UCRL-99356
PREPRINT

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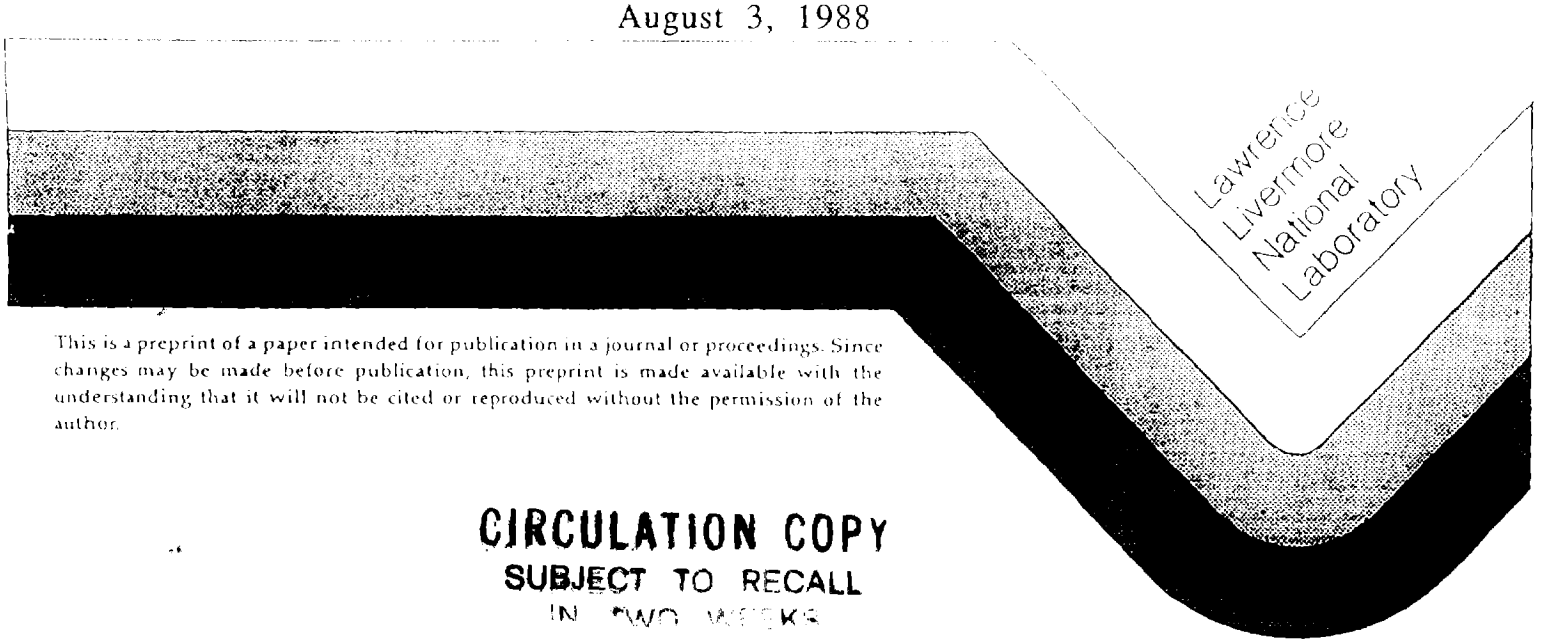
This paper was prepared for submittal to
The Computer Society
13th Conference on Local Computer Networks
in Minneapolis, Minnesota
on Aug. 5, 1988

August 3, 1988



Workstation Fiber Panel

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This note discusses the decision process used by LLNL to install fibers from the office to the local wiring closet.

LLNL's Decision to Install Fiber in Every Office

Recently at the Lawrence Livermore National Laboratory we made the decision to replace our Centrex phone system with a new "privately" owned digital PBX. This decision was primarily driven by economic considerations as our analysis showed that we would save $40 million over the next 10 years if we did so.

Because of the condition of our on-site wiring (poorly documented, multiply terminated, impossibly congested and in some places physically damaged), it made economic sense to completely rewire the site with a modern nodal distribution system. As we had gone this far with rewiring the site, we also included medium (10MBit/sec) and high (1GBit/sec) speed data distribution facilities in the wiring upgrade. Our new nodal system will allow us to add new facilities to our site without making home runs to a central distribution facility as we are currently doing. Node locations are defined by the requirement that each office or potential office be within 2,000 wire feet of a node. The 2000 foot distance was originally set by our early desire to allow inexpensive 1 MBit/sec. transmission on twisted pair form the office to the node. As discussed below, a site wide Ethernet was chosen instead. But, the 2000 foot office to node distance requirement is still reasonable in light of current 1 GBit/sec. multimode fiber technology. This requirement has resulted in 11 nodes on our 1 square mile site.

As a result of contract negotiation with AT&T, we are installing a hierarchy of ethernets to handle our medium bandwidth data. Each office is being wired so that it can have its own twisted pair Ethernet connection. These wires go from the office to a local wiring closet. At the closet the twisted pair interfaces are connected to a thickwire Ethernet backbone which runs through the wiring closets in the building and includes the building central distribution area. Each building is then connected, via a bridge at the building distribution frame (BDF) and fiber optics, to the local node where all buildings in the node are collected on another thickwire Ethernet. The nodes are then connected, via another bridge in the node intermediate distribution frame (IDF) and fiber optics, to our main distribution facility where an Ethernet, which allows facility wide connectivity, resides.

At present all of the twisted pair wiring from the offices to the wiring closets is being installed. Electronics, the thick wire Ethernet in the buildings, and the fiber between the building and the node are only being put in place for those buildings and users which are currently on our broadband Labnet Ethernet backbone. As discussed below, we are placing adequate spare conduit between the buildings and the nodes to allow installation of Ethernet electronics, and node to building fiber as building residents decide they wish to join the lab wide system. All of the internodal fiber and electronics are being installed at this time. We plan, in the future, to upgrade the internodal layer of the system to a higher bandwidth technology as network traffic increases. We are presently thinking in terms of an Artel or Fibercom system operating in the 100 MBit/sec. region with eventual use of FDDI. This medium speed Ethernet will replace our existing site wide broadband coax backbone which presently provides this connectivity but is difficult to maintain and limited in single-channel bandwidth.

To cover our future anticipated high speed data distribution requirements, we included in the contract both the installation of fiber from each office to the nearest wiring closet and a requirement for spare conduit. The required spare ducts are to be placed in all areas of the site where we had to dig for any duct placement. The percentage of spare ducts required never drops below 22% (7 required vs 2 spares) and is generally greater than 25%. If one duct is required to handle telephone and Ethernet connectivity in a given building, a minimum of one spare duct is also being

placed. This sparing philosophy is carried through from the main distribution frame (MDF) to the BDFs. Each 4 inch duct will handle seven 144 strand 62.5 μm multimode AT&T fiber cables for a total of 1008 fibers. Cost of the fiber, interduct, and installation labor is approximately $36 per foot for the first 144-fiber cable in a given duct and $34 per foot for each of the other six cables.

The last item we included in our telephone upgrade was fiber to the office. From the building distribution frame (or wiring closets) to individual offices we are installing two 62.5 μm multimode fibers. The basic labor costs for doing this portion of the wiring for our site was estimated at $1,300,000 of which $60,000 was the cost of the wire. The cost of sufficient fiber to pull to each of our 7000 offices was estimated to be $330,000 (it actually came in at $367,000). Given these relative cost ratios, we decided to take advantage of the labor and install "dark fiber" to the offices.

In our judgement, 62.5μm multimode fiber was the fiber of choice because both AT&T and DEC have embraced it as a standard which they support. The average length of these office fiber runs is 150 feet. Therefore, even if we decided to go to a higher bandwidth fiber later, the insertion of this length run of 62.5 μm multimode fiber should not seriously affect overall performance.

Our basic justification for installation of the fiber was our feeling that in the next 10 to 15 years we will see the requirement for data transfer rates to the office which will allow saturation of the human senses. Human tactile bandwidth is only a few hundred bits/sec. (For instance, a typist typing 60 words per minute only generates 40 bits/sec.) Our aural bandwidth is on the order of 320 Kbits/sec (when you are young and have good hearing). On the other hand, our visual bandwidth is on the order of 1.5 Gbits/sec. It is our feeling that computer and display devices will continue to develop until they reach saturation of our input channels. At the present rate of development, it appears that this is only a few years off. Therefore, given the ratio of material to labor cost, we decided to anticipate these developments and take advantage of the labor involved with upgrading our telephone system. We think that we have installed what undoubtedly will be the medium of choice for handling higher bandwidths in the future - FIBER. We hope that, in this manner, we have installed a distribution system which will adequately meet our needs in future years.

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract No. W-7405-Eng-